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DSA BULLETIN 08-05

Effective Date: June 9, 2008

To: **DSA Staff and Interested Parties**

From: **Division of the State Architect Department of General Services State of California**

SUBJECT: **Calculation of Out-of-Plane Deflection for Alternative Design of Concrete Slender Walls**

Purpose: The purpose of this bulletin is to recommend the use of the revised procedure in ACI 318-08, Section 14.8 for the calculation of out-of-plane deflection in lieu of the procedure in ACI 318-05, Section 14.8.

Background: ACI 318-05 is the current referenced standard in the 2007 California Building Code (CBC).The procedure prescribed in ACI 318, Section 14.8 is an alternative to the requirements of Section 10.10 for the out-of-plane design of slender wall panels, where the panels are restrained against overturning at the top.

American Concrete Institute (ACI) has re-evaluated the original test data upon which the out-of-plane deflection formula were derived and prescribed in the current edition (2005) of ACI 318 Section 14.8.4, and concluded that out-of plane deflection increases rapidly when the service-level moment exceeds **(2/3)** M_{cr}.

Policy: If an engineer wants to use Section 14.8 as the alternative design procedure to the requirements of ACI 318, Section 10.10, DSA would recommend the alternate deflection procedure indicated below.

1. Alternate Procedure: The text of ACI 318-05 shall be modified as follows:

1.1 Modify Equation (14-7) of ACI 318, Section 14.8.3 as follows:

$$I_{cr} = \frac{E_s}{E_c}\left(A_s + \frac{P_u}{f_y}\frac{h}{2d} \right)(d-c)^2 + \frac{l_w c^3}{3} \qquad (14\text{-}7)$$

and the value of E_s / E_c shall not be taken less than 6.

1.2 Modify ACI 318-05, Section 14.8.4 as follows:

14.8.4 – Maximum out-of-plane deflection, Δ_s, due to service loads, including $P\Delta$ effects, shall not exceed $l_c/150$.

If M_a, maximum moment at mid-height of wall due to service lateral and eccentric loads, including $P\Delta$ effects, exceed $(^2/_3)\ M_{cr}$, Δ_s shall be calculated by Equation (14-8):

$$\Delta_s = \frac{2}{3}\Delta_{cr} + \frac{M_a - \frac{2}{3}M_{cr}}{M_n - \frac{2}{3}M_{cr}}\left(\Delta_n - \frac{2}{3}\Delta_{cr}\right) \qquad (14\text{-}8)$$

If M_a does not exceed $(^2/_3)\ M_{cr}$, Δ_s shall be calculated by Equation (14-9):

$$\Delta_s = \left(\frac{M_a}{M_{cr}}\right)\Delta_{cr} \qquad (14\text{-}9)$$

where:

$$\Delta_{cr} = \frac{5 M_{cr} l_c^2}{48 E_c I_g}$$

$$\Delta_n = \frac{5 M_n l_c^2}{48 E_c I_{cr}}$$

I_{cr} shall be calculated by Equation (14-7), and M_a shall be obtained by iteration of deflections.

2. Service-Level Load Combinations: Service-level load combinations are undefined in ACI 318, Chapter 9. For calculating the service-level out-of-plane deflections of structures, ACI references Appendix C of ASCE/SEI 7-05, which recommends the following load combination:

$$D + 0.5L + 0.7W$$

3. Earthquake Effect: When earthquake effect E is being evaluated and E is based on strength-level seismic forces, ACI recommends the following load combination for evaluating service-level out-of-plane deflection:

$$D + 0.5L + 0.7E$$